U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1400

ESTABLISHING CRANBERRY FIELDS

THE CRANBERRY was first cultivated about 1820 in eastern Massachusetts, and except for a few hundred acres devoted to it in Canada its culture is almost wholly confined to the United States. In the past hundred years the area planted to this fruit has been gradually extended until now there are about 30,000 acres under vines, with the chief centers in eastern Massachusetts, central and southern New Jersey, central and northern Wisconsin, southwestern Washington, and northwestern Oregon. Natural conditions have favored the development of the cranberry in these regions, where nearly the entire commercial crop is produced.

This bulletin gives directions for establishing cranberry fields. It discusses many principles involved in cranberry growing. Other bulletins which should be read in connection with it are Farmers' Bulletin 860, Cranberry Insect Problems and Suggestions for Solving Them; Farmers' Bulletin 1081, Cranberry Diseases and Their Control; Farmers' Bulletin 1401, Managing Cranberry Fields; and Farmers' Bulletin 1402, Cranberry Harvesting and Handling.

Washington, D. C. Issued March, 1924

ESTABLISHING CRANBERRY FIELDS.[1]

By GEORGE M. DARROW, *Pomologist, Office of Horticultural Investigations, Bureau of Plant Industry;* HENRY J. FRANKLIN, *Superintendent of the Cranberry Substation, Massachusetts Agricultural Experiment Station;* and O. G. MALDE, formerly *Superintendent, Wisconsin Cranberry Experiment Station.*

CONTENTS.

THE RAISING of cranberries is localized and is limited to those parts of the country where the peculiar requirements are met. The land suitable for cranberries, and the methods used in raising them, are adapted to few other crops.

Figure 1 shows the present distribution of the industry. The principal sections producing this fruit are the Cape Cod region of Massachusetts, the Pine Barren region of New Jersey, and central and northern Wisconsin. The industry is carried on in a smaller way near the mouth of the Columbia River and on the eastern end of Long Island, and there are scattered fields in Maine, New Hampshire, Rhode Island, Connecticut, Virginia, Minnesota, and Michigan.

Cranberries are little grown outside of the United States. About 100 acres are being cultivated in Nova Scotia, and they have been tried in Norway, the Netherlands, and Denmark, though as yet with little success. One bearing field of about 30 acres in the Netherlands is reported.

The first attempts to cultivate cranberries were made on Cape Cod, at North Dennis, Mass., between 1810 and 1820. Little success attended these efforts, and it took until about 1850 to accumulate sufficient experience to produce the crop successfully. By that time it was known that the cranberry could be grown only on certain soils, that the use of sand increased the crop, and that flooding protected the vines from winter injury. After 1850 both the number of growers and the acreage increased rapidly.

The first plantings in New Jersey were made about 1845, on Long Island about 1865, in Wisconsin about 1874, and in Oregon about 1885.

The acreage, estimated production, and farm value of the crop for a series of years are given in Table 1.

[1] In Massachusetts and New Jersey the name "bog" is commonly applied to areas planted to cranberries, though very small areas are referred to as "yards." In Wisconsin the word "marsh" is used in place of "bog." The words "bog" and "marsh" both refer to swampy ground. The popular conception of a bog or marsh is a swamp where mosquitoes breed, a nuisance in any neighborhood. Neither term, then, is fitly applied to a developed well-drained cranberry property. To apply a term in keeping with modern methods of raising cranberries the term "field" is used in this bulletin, and a properly drained area planted to cranberries is called a "cranberry field."

REQUIREMENTS OF CRANBERRY GROWING.

Before undertaking to develop a swamp or marsh into a cranberry field one should consider the following points:

(1) Considerable capital is required to develop a cranberry property. Few fields that were improved in the last 10 years before the war cost less than $500 an acre up to the time of bearing, and some cost more than $1,500. Almost no new areas have been developed since 1914, but the increased cost of labor and materials needed to improve such a property must be included in estimating the present expense.

(2) This fruit requires an acid peat soil. Neither alkaline peat nor ordinary farm and garden soils will grow cranberries. The present commercial centers of the industry afford proper soils, while extensive peat swamps, especially in Minnesota and to the westward, are alkaline and therefore not suitable.

(3) A constant and ample water supply is needed for irrigation during droughts and for flooding to protect the plants against winter injury, untimely frosts, and injurious insects.

(4) It must be possible to drain the swamp to a depth of at least 18 inches.

(5) Except in New Jersey, the field should be near a supply of clean sand.

(6) A climate with moderately cool summers is necessary. The New Jersey and Massachusetts cranberry districts are near the coast and have fairly cool summers, while the Wisconsin region is farther north. The industry would hardly succeed where summers are much warmer than in New Jersey. In that State the berries often rot on the vines, and the prevalence of diseases necessitates much more spraying than in other commercial sections. Diseases probably would be even more serious farther south, and the high temperatures during harvesting and after picking would shorten the life of the berries and increase the difficulty of marketing.

(7) The summer temperatures must not be so low as to retard blossoming, the development of the berries, or the growth of the vines. The shortness of the growing season and the coolness of the summers probably will prevent the extension of the industry much farther north than Nova Scotia. In some seasons cool cloudy weather lengthens the blossoming period in Oregon and Washington, so that the berries mature very unevenly.

(8) The present centers of the industry are probably among the most favorably located sections for cranberry development. To develop new sections requires years of work in selecting varieties, learning the sectional peculiarities affecting the business, and the training of adequate help.

(9) Experience is a very important factor in this industry, and to acquire it is a matter of years. Acquaintance with ordinary lines of farming is of little value, since, to succeed, one must become expert in controlling the insects and diseases affecting the vine and fruit, in handling water for irrigation and flooding, in frost forecasting, and in the general management of a cranberry field.

TABLE 1.—*Acreage, average yield per acre, estimated production, average price per barrel, and farm value of cranberries in 1899, 1909, and 1914 to 1922.*[1]

Year.	Acreage.	Production (barrels).		Value (price on Dec. 1, as basis).		
		Average per acre.	Total.	Average per barrel.	Total.	Per acre.
1899	20,434	15.6	319,516	$3.80	$1,215,059	.....
1909	18,431	20.7	383,430	4.59	1,755,000	.....
1914	22,000	31.7	697,000	3.97	2,766,000	.....
1915	23,100	19.0	441,000	6.59	2,908,000	.....
1916	26,200	18.0	471,000	7.32	3,449,000	.....
1917[2]	18,200	13.7	249,000	10.24	2,550,000	.....
1918[2]	25,400	13.9	353,000	10.77	3,791,000	.....
1919	26,100	20.7	541,000	8.36	4,520,000	.....
1920[2]	25,000	18.0	449,000	12.28	5,514,000	$220.56
1921[2]	25,000	15.4	384,000	16.99	6,526,000	261.04
1922[2]	25,000	22.5	562,000	10.18	5,720,000	228.80

[1] The figures for 1899 and 1909 are as given by the census reports. The figures for the years 1914 to 1922 have been furnished by the Bureau of Agricultural Economics.

[2] Only the acreage producing a crop is included in the figures given. Because of frost injury, considerable acreage had no crop and was not reported, the average yield being smaller on this account.

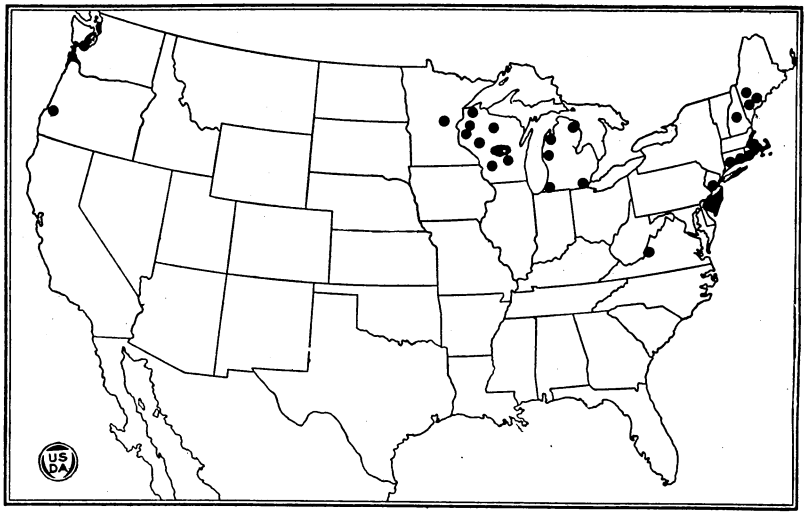

FIG. 1.—Outline map of the United States, showing the regions in which cranberries are grown commercially. The most important growing sections are eastern Massachusetts, New Jersey, Wisconsin, Long Island, N. Y., western Washington, and Oregon. Dots in Maine, New Hampshire, Rhode Island, Connecticut, Virginia, Michigan, and Minnesota indicate the location of scattered small fields.

On January 1, 1922, the acreage in the various States was about as follows:

	Acres.
Massachusetts	14,000
New Jersey	13,000
Wisconsin	1,900
Washington	500
New York (Long Island)	277
Oregon	120
Rhode Island	82
Minnesota	30
Michigan	22
Maine	15
Connecticut	10
New Hampshire	5
Virginia	3
Total	29,964

With suitable land and experience, one should be able to make fair profits. The records of most cranberry fields managed by skillful growers show losses in some years and profits in others, yet in a score of years average a fair return on the investment.

The average price of the fruit sold by the grower for the years 1907 to 1917, inclusive, was about $6.40 a barrel. For the years 1918 to 1920 the average selling price of the American Cranberry Exchange was $8.71 a barrel (deducting 25 cents per barrel for advertising expense), which fairly represents the average price received by the growers for cranberries in recent years.

The cranberry acreage has steadily increased during the last 50 years except during and since the World War. The industry has developed varieties much superior to the wild mixed vines formerly used. Insects and diseases have been studied and control methods devised. Improved machinery and tools have been invented, weed control has been improved, and cooperative marketing of the product organized. Each factor which limits development has been studied in turn, and a solution of the difficulties has been or is being found. In fact, the whole industry has made a sound, progressive growth.

BOTANICAL RELATIONSHIPS OF THE CRANBERRY.

Three types of the cranberry, only the first of which has succeeded under cultivation, grow in the United States—the common, large-fruited one; the moss, gray, speckled, or small cranberry; and the European cranberry.

Vaccinium macrocarpon, the cranberry of commerce, is native to North America and is found in swamps, growing on peat deposits as far south along the Atlantic coast as Hyde County, N. C. It grows in abundance in certain localities in the swamp areas of northeastern North Carolina. It is also found in the mountains of West Virginia, in Ohio, Indiana, Illinois, Arkansas, Minnesota, Wisconsin, and Michigan, and northeastward to Newfoundland.

Vaccinium oxycoccos, the "moss," "gray," "speckled," or "small" cranberry, grows on swamp peat as far south as the mountains of North Carolina, in Michigan, Wisconsin, Oregon, Washington, and into the far North, as well as in northern Europe and Asia. The vine and fruit of *V. oxycoccos* are smaller than are those of *V. macrocarpon*. (Fig. 2.). This berry failed under cultivation in Wisconsin and Washington under conditions favorable to the common large-fruited cranberry. It is gathered occasionally in small quantities in the wild and makes delicious jelly and preserves. A variety of this species, *V. oxycoccos* var. *ovalifolium*, with somewhat larger fruit, is found in the same Eastern States as is the type; also in Idaho and along the Pacific Coast in Oregon and Washington, and in Asia.

Vaccinium vitisidaea, the "European," "mountain," or "rock" cranberry, is called also the "lingon" or "kroesa" berry in Denmark and Sweden; "tyttebaer" in Norway, Denmark, and Germany; "cowberry" and "foxberry" in Great Britain; and "partridge berry" in Newfoundland. It grows in northern Europe and Asia and is represented in North America by the variety *minor*, which occurs on the mountains in Maine, New Hampshire, and Vermont, at Cape Ann, Mass., quite commonly in eastern Maine, in Newfoundland and Labrador, and westward to Alaska. It grows on upland and in rocky places rather than in swamps. Both the fruit and plant of this variety are smaller than the type of *V. vitisidaea*, but it is gathered commercially in eastern Maine, Newfoundland, Labrador, and northern Canada, westward to Alaska, and small quantities occasionally appear in the markets of the United States.

In Europe great quantities of fruit of *V. vitisidaea* are gathered in the wild and sent to the markets, especially from northern Russia, Finland, northern Sweden, and Norway. Smaller quantities are gathered in other European countries. There are said to be at least 40 factories in northern Sweden for evaporating this fruit, and a large amount is evaporated in Den-

mark also. The evaporated product is used for making sauce and preserves. Small quantities have been imported into America for those accustomed to its use in Europe.

The vines of this species are low and form a dense carpet over the ground. The berries are much smaller than the common large-fruited cranberry, resembling an elongated wintergreen berry. They grow in clusters at the end of the shoots and are gathered chiefly by hand, but also by small scoops similar to those used in the blueberry industry in Maine. This species has not been cultivated either in Europe or America, and its fruit seems too small to encourage the attempt.

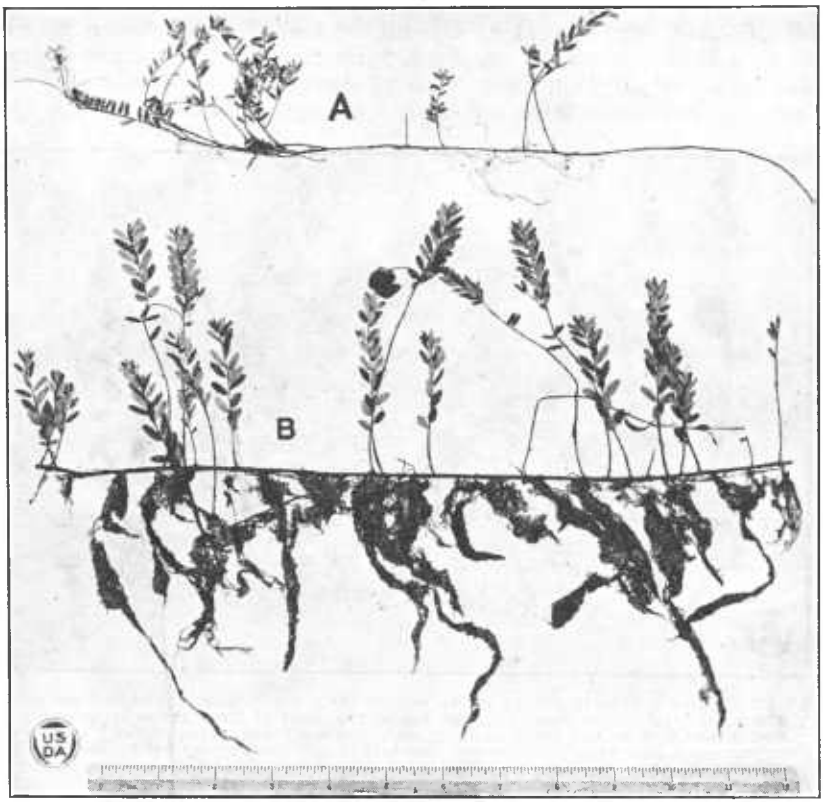

FIG. 2.—*A*, The slender runner and uprights of the moss cranberry (*Vaccinium oxycoccus*); *B*, the stronger runner of the common cranberry of commerce. Note the roots starting from numerous points along the runners.

Huckleberries and blueberries are closely related to the cranberries. Recent experiments[2] have shown that the blueberry may be profitably cultivated and that it also requires an acid peat soil.

CHARACTERISTICS OF THE CRANBERRY.

Because the cranberry differs in both character and culture from other crops, those features of the plant and fruit which are important in determining methods of cultivation are discussed here.

[2] Coville, Frederick V. Directions for blueberry culture. 1921. U. S. Dept. Agr. Bul. 974, 24 p., 29 pl. 1921.

SEEDLINGS.

Figure 3 shows three seedlings at the end of their first season's growth. Under average conditions it takes four or five years from the seed to bring the plants into bearing. Since they do not come true to seed and the growth of seedlings is comparatively slow, the cranberry is not propagated from seeds but by cuttings.

ROOTS.

Roots may start out at any point on the vine, as shown in Figure 2, and the plant is supplied with food and moisture from a mass of roots all along the runners instead of from a single root system. When new fields are started advantage is taken of this root-

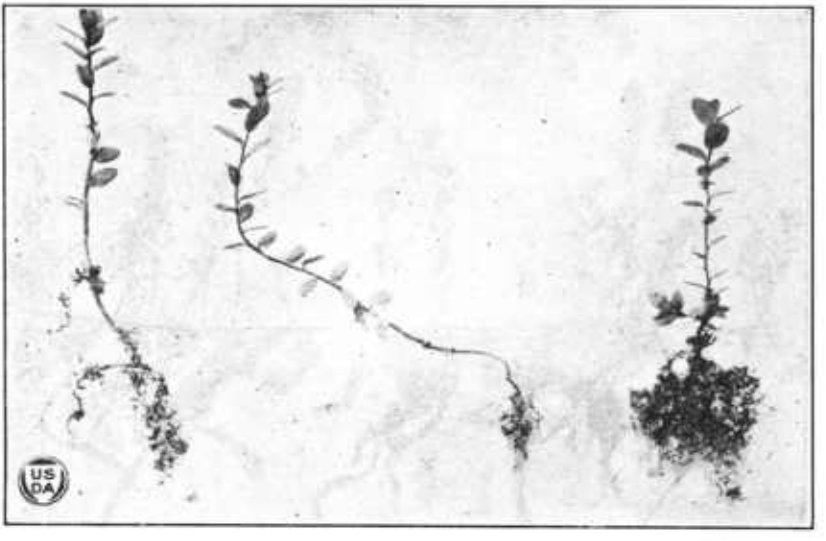

FIG. 3.—Three cranberry plants at the end of their first season's growth from seed. The total height from root tip to the top of the plant at the right is 2½ inches. It would take four or five years to bring such seedling plants into fruiting. Varieties do not come true from seed; hence, cranberries are not propagated by seed but by cuttings.

ing habit by planting cuttings, and as these root readily the cost is much less than that of rooted plants. Figure 4 shows rooted cuttings after making two seasons' growth.

The root system of the cranberry differs widely from that of ordinary farm crops. It consists of a mass of fine fibrous roots having no root hairs such as are found on most plants. The roots are confined chiefly to the upper 3 or 4 inches of soil, which they fill almost entirely. On well-drained areas covered with 3 or 4 inches of sand they have been found extending 8 to 12 inches below the surface. Figure 5 shows the difference in root growth in poorly drained and in well-drained soils.

The roots will not grow under water, even though the wild vines grow in bogs or marshes, but they will live under water for months,

and it is reported that plantings have sometimes survived flooding through two successive winters and the intervening summer, though in a weakened state.

Slight root growth usually begins with warm weather in the spring. It continues through the summer and, like that of the blueberry, is probably greatest in late summer and fall.

FIG. 4.—Plant growth from cuttings set two years previously. Few roots have grown from the lower part of the cuttings, most of them starting from the upper 3 inches. The 2 inches just above the bend were in the peat, which helped to keep the cuttings moist.

UPRIGHTS.

The cranberry vine consists of runners and uprights. Figure 6 shows uprights which have grown from lateral buds along a runner. Uprights never bloom the first year but will blossom the second year under normal conditions.

LATERAL AND TERMINAL BUDS.

A cranberry runner has lateral buds in the axils of the leaves and a terminal bud [3] at the end. The lateral buds usually remain dormant unless the terminal one is injured, in which case one of them may take the place of the terminal in continuing the growth of the upright, as upright No. 1 in Figure 6 has done.

Terminal buds on runners simply continue the growth of the vine, rarely producing blossoms, while those on uprights under favorable conditions produce blossoms.

By a careful examination of the buds in the tips of the uprights it is possible in the fall or winter to judge fairly well the blossom prospects for the following year. Some of the tip buds are stout; others slender. Most of the stout buds will send out shoots bearing blossoms; none of the slender ones will do this. Figure 7 shows at

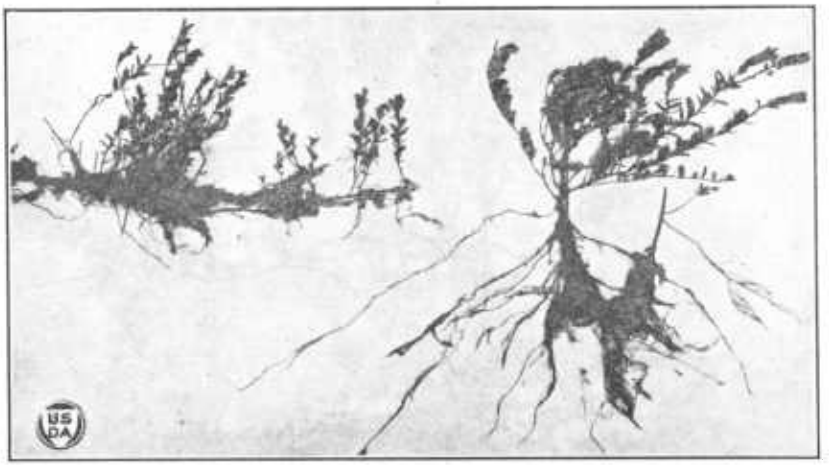

FIG. 5.—Cranberry root systems. The plant to the left is from a poorly drained field without sand; the one to the right is from a well-drained field covered with 3 inches of sand. Photographed in Wisconsin.

the right a bud that probably will develop blossoms, while the one to the left has one that will not.

Blossom buds usually will be killed under the following conditions:

(1) If the vines are exposed in winter to long-continued, cold drying winds while the soil containing the roots of the plants is frozen.

(2) If a frost with a temperature below 25° F. occurs in the spring after the buds have swelled to a diameter of more than 0.08 inch, or enough to show a bright-green color where the scales overlap.

(3) If hard spring frosts occur after the buds have opened.

(4) If conditions in the spring are such that a rapid growth of new uprights absorbs the energies of the plant.

---

[3] When the terminal bud is large it is commonly called a "blossom bud" but is really a shortened stem. The true blossom buds are in the axils of the small inner scales of the terminal bud. When this bud unfolds in the spring the stem elongates, the scales become distributed along this stem, and in the axils of the inner scales small buds appear, which develop into the blossoms. In Figure 6 the second upright from the left shows several scales without fruit, above which are several scales with fruits just developing. The upright continues its growth, leaves develop above the blossoms, thus forming a new tip, and if conditions are favorable the terminal bud of this tip during the fall may in turn develop into a "blossom bud."

(5) If the growing shoots are left too long under water in flooding to protect them from insects or spring frosts.

(6) If the uprights when in an active growing condition are submerged very long during cloudy weather.

BLOSSOMING SEASON.

The blossoming season of the cranberry extends over a considerable period, occuring during June and July. In Massachusetts the normal season of bloom is about June 25 to July 18, but it varies with the season and field conditions, extending into August if the winter flood is held late. In the other cranberry sections if the winter flood is held late the season of bloom will likewise be delayed. The dif-

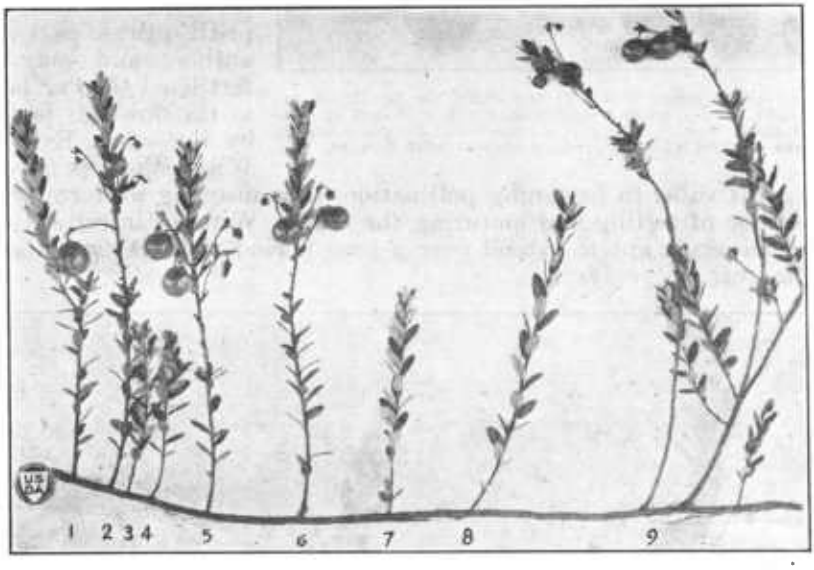

FIG. 6.—Part of a cranberry runner with uprights. Upright No. 1 is making its second season's growth, but it started the second year from a lateral bud and developed no blossoms. Nos. 2, 5, and 6 are also in their second year of growth, but started the second season from terminal buds, developing flowers and berries. Nos. 3, 4, 7, and 8 started from buds on the runner during the current season and, as here shown, have made two to three months' growth. No. 9 has grown three seasons, developing flowers and herries the last season. Photographed July 17, 1917, in New Jersey.

ferent varieties vary in their blooming, the Early Black, for example, usually blossoming about a week before the Howes. Figure 8 illustrates the blossoming habit and the setting of fruit.

THE CRANBERRY BLOSSOM AND ITS POLLINATION.

Cranberry blossoms are shown in Figure 9. Each blossom has a small slender pistil surrounded by five stamens with tiny openings at the ends, from which come minute pollen grains to fertilize the flowers.

Results of investigations by the Massachusetts Agricultural Experiment Station indicate that in that State cranberry blossoms are pollinated by bees. Bumblebees and honeybees seem to be the chief agents of pollination. As the former are not always abundant many growers keep small apiaries.

Bees are not common in the cranberry region of Wisconsin, and experiments and observations by representatives of the Wisconsin Agricultural Experiment Station indicate that though they help in pollination they are not necessary in that State under normal conditions. The cranberry blossoms there seem to be practically self-fertile. After the flower bud opens, as shown in Figure 8 in the center upright, the pistil grows past the anthers and may be fertilized then or later as the flower is jostled by the wind. Even in Wisconsin bees may be of great value in hastening pollination, thus insuring uniformity in the time of setting and maturing the fruit. Without insect aid the pollination is apt to extend over a long period and the fruit likely to mature unevenly.

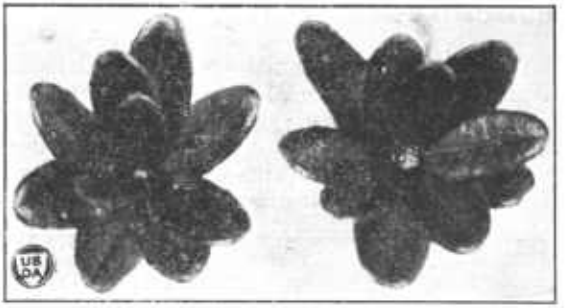

FIG. 7.—Terminal buds: At the right, the tip of an upright with a stout winter bud which will develop into a shoot bearing flowers. At the left, the small bud in the upright will not produce a shoot with flowers.

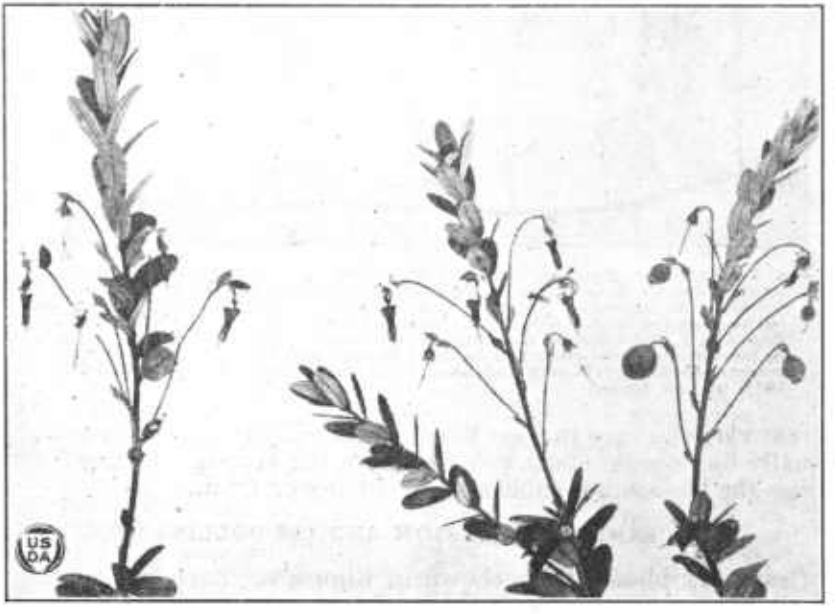

FIG. 8.—The blossoming and fruit setting of cranberry vines. On the upright at the left are four flowers and one bud; on the center one, four flowers and two berries just setting, the latter being in the two lower flower stems; and on the right one flower and five berries set. Photographed July 17, in New Jersey.

THE FRUIT.

After pollination the stamens and petals soon drop. The berry grows rapidly and matures in from 60 to 90 days.

Some varieties of cranberries are globose; others are elliptical, bell-shaped, or pear shaped, and some are ribbed, giving them a four-sided appearance. Other things being equal, the globose or round berries are preferable, because they are very easily cleaned and prepared for market and usually ship in the best condition. A barrel of one variety may weigh 10 to 15 pounds more than the same quantity of another. Fruit of the same variety grown in different localities or on different soils often varies considerably in weight.

Most cranberries as they develop are first green, then greenish white, then pink, and finally red. Some wild berries are greenish white when ripe; some of the cultivated varieties become so dark red that they are almost black, while others are greenish or light red in color with dark-red dots or stripes on the surface.

The Early Black, a leading variety in New Jersey and Massachusetts, ripens early in September. The berries of this variety usually keep better if picked before they turn dark red; if not picked before late September they rot quickly. The Howes variety ripens in early October, and in Massachusetts at least the later it is picked the better it keeps. Other varieties have their own period of ripening; some early, some late.

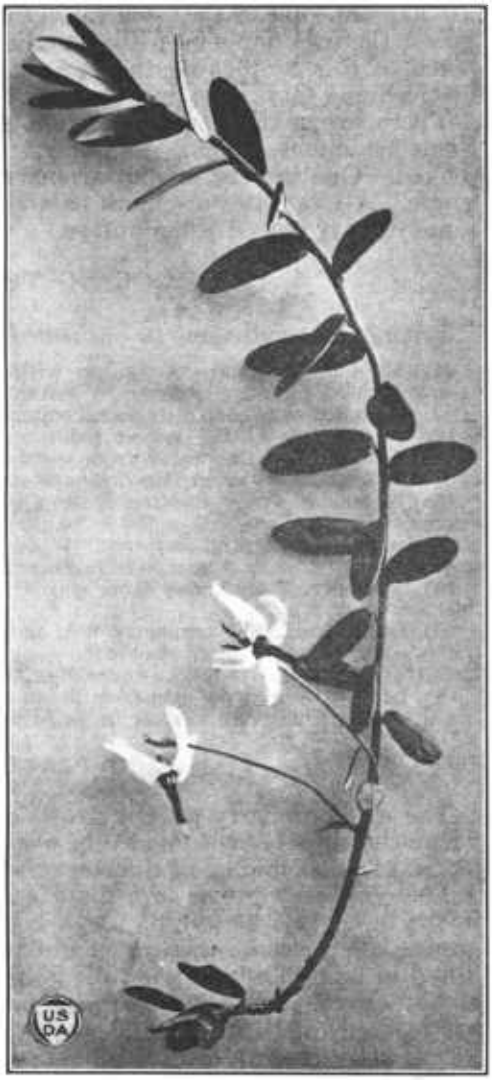

FIG. 9.—Cranberry blossoms. Note the pistil surrounded by stamens. Photographed June 15, 1914, at Pemberton, N. J.

If cranberries are picked in the greenish white stage before ripening they will color somewhat during storage, the amount of reddening depending on the variety, ventilation, and temperature. The color developed in storage, however, is not as brilliant or as deep as that which the berries have when they ripen on the vines. The coloring matter is located entirely in the skin, but if a berry is spoiled by frost or

smothered in prolonged storage the color will spread through the entire berry.

The deeper the color of a cranberry the more severe the frost it will endure. An immature green berry will be injured by a temperature of 28° F.; an uncolored (greenish white) one will endure 27° F.; while one of the same variety deeply colored will stand 23° F. When there is danger of frost at harvest time, advantage may be taken of this by picking the areas having the lighter colored fruit first, leaving those with darker colored berries until later if necessary.

There are marked differences in table quality among varieties. Some are intensely acid. Others are mild enough to be relished uncooked. One variety has an aroma reminding one of the Concord grape. All varieties are more palatable if they mature fully on the vines than if picked when unripe.

CHOOSING THE SITE.

Among the conditions to be looked for in choosing a site are:

(1) An acid peat soil. A swamp with a good growth of "leatherleaf"[4] (brown brush) or cedar is generally suitable.

(2) Such drainage that the general water table may be held at least 18 inches below the surface at the lowest point on the property. The drainage also should take care of the water from spring freshets and heavy rains and accord with State laws regarding drainage where such laws exist.

(3) Water for winter flooding is essential. A further supply for irrigating during the growing season and for flooding to protect from frosts and to destroy harmful insects is desirable. When the water is to be taken from a public pond or from a stream certain State laws must be complied with.

(4) A supply of sand, free from clay or loam, located near the prospective field.

(5) Level land. The cranberry field must be level or nearly so. As grading is costly, that required should be kept at a minimum by the selection of sites that are as nearly level as possible.

(6) Land as free as possible from brush and timber.

(7) Swamps long and narrow in shape and not too great in area.

ACID PEAT SOIL.

The wild cranberry usually grows on acid peat and sand in places where the vines become flooded in winter. The site chosen for a commercial field should be of that sort; never upland soil.

The cranberry grows in a plant association typical of one period in the history of a swamp. As a lake or pond fills up, water lilies appear, then rushes, then moss and bushes, such as leatherleaf, followed in turn by blueberries, then cedars, and finally swamp maples and other trees. The cranberry is found on that part of a bog which has reached the "leatherleaf" stage, and a bog covered with leatherleaf is considered an ideal site for cranberries.

The following types of swamps, in the order of their importance, are most used for cranberry fields:

Leatherleaf, sphagnum, and heath swamps.—These are often naturally flooded in winter, and only those should be selected that can be drained properly. Though most swamps of this type in the larger cranberry-growing regions have already been planted, there are thousands of acres of such areas

[4] *Chamaedaphne calyculata.*

in other sections which may sometime be developed. Figure 10 shows a "leatherleaf" swamp before conversion into a cranberry field.

White-cedar swamps.—This type usually has deep peat, and many of the best cranberry fields have been made from such swamps. Spruce and tamarack swamps in northern Wisconsin are similar in composition.

Red-maple swamps.—These often have a shallow layer of peat or peat mixed with sand. Many good fields are found on this type.

Mixed-tree swamps.—Red maple, pine, and mixed growth are found in these swamps, which are similar to those of red maple.

Grassed swamps ("fresh" meadow and swales).—In Wisconsin, and sometimes in Massachusetts, swamps covered with grass have been made into cranberry fields. These are free of timber and usually can be plowed. They are therefore inexpensively developed and often prove very satisfactory.

"*Gray-sands*" *swamps* ("*savannas*").—Sand "bottoms" covered with a few inches of "upland peat" (leaf mold) are sometimes planted in Massachusetts and in New Jersey and are usually very profitable.

Pond bottoms.—A pond is drained and the muddy bottom covered with sand and planted.

Though the cranberry soils are listed above as belonging to seven different classes, each type is variable. Seldom are all parts of the

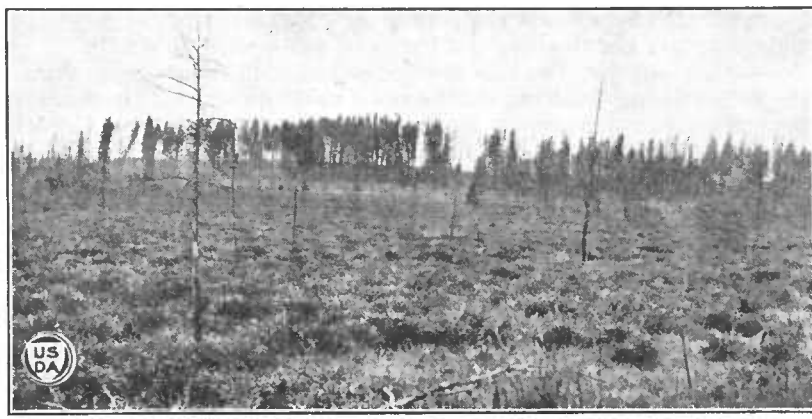

FIG. 10.—A "leatherleaf" or "brown-bush" swamp, which is considered a very desirable site for a cranberry field. Spring Brook, Wis.

same swamp alike. Often in planting a field that is mostly peat a small area of sand bottom is included. Vines on this sand commonly grow more slowly than those on the peat, but often produce well eventually.

DRAINAGE.

In selecting cranberry land care should be taken that its water relations are thoroughly understood. The whole drainage system must be carefully surveyed before improvement is begun. It should be possible to drain so that the water table will be at least 18 inches below the surface in the lowest part. Poor drainage encourages troublesome weeds, makes picking more difficult, reduces the crop, and impairs the keeping quality of the berries. At one property a pump is used daily throughout the growing season to remove surplus water. This, however, is an extreme measure and is seldom necessary. Laws governing the drainage of swamp lands are in force in most States and should be understood before one goes into such work.

WATER SUPPLY.

The supply of water, even in the driest season, should be adequate for flooding to protect the crop from frost and insects. If a reservoir is depended on, it should have sufficient capacity to hold water enough for the driest season. If the water is taken from a lake or stream the minimum supply must be known, and the rights of others and the State laws governing the use of such sources must be considered. In Massachusetts there are special cranberry statutes in this connection. If pumps are to be used to supply water, it must be ascertained whether the water for flooding can be economically obtained in that way.

Where possible a cranberry field should be located on or close to a good stream of water capable of furnishing quick flowage at any time during the year. In case the stream is not sufficient of itself, a reservoir should be built. In Massachusetts and New Jersey the reservoir should be as far upstream from the field as is practicable; no more water than is absolutely necessary should be kept in it during the growing season. If the reservoir is near and is kept full, seepage impairs the drainage of the field and makes it weedy.

Protection against frost is needed oftener in Wisconsin than in other sections, and flooding can be done more quickly if the reservoir is near the field than when located at a distance. Such a location is usual in that State and may be best notwithstanding the bad effects of seepage.

SAND.

The use of sand on cranberry fields is considered essential in all sections except New Jersey, and even there some growers use it and think it necessary. A coarse clean sand free from loam and silt, or nearly so, should be used where obtainable. Though a poor grade of sand is better than none, the results secured from its use are less satisfactory than when coarse clean sand is used. Screened gravel sometimes is used where sand is not available. In the northern half of Wisconsin a fine sand free from silt is found near most swampy areas and is far better than none when the coarse sand is not available.

FREEDOM FROM BRUSH AND TIMBER.

The more nearly free the land is from brush or timber the better, for it is more easily and economically improved than if timbered. "Fresh" meadow frequently has been converted into a cranberry field without turfing, the grass being simply covered over with about 3 inches of sand and the vines planted without other preparation except ditching. Other meadows have been plowed, leveled, sanded, and planted. Such fields are developed inexpensively and in most cases have been satisfactory. Swamps covered with brush are generally preferred to wooded ones, because it costs less to clear them.

SWAMPS OF SMALL SIZE AND LONG AND NARROW IN SHAPE.

Fields of a few acres give relatively much better returns than large ones. Long and narrow fields are more profitable after a certain limit

in size is reached than are those more nearly square in form. The cost of maintenance and of harvesting the crop is disproportionately large in the case of large square or round fields, particularly because it takes so much time to wheel sand to the center of the field and to bring the berries to the upland from the center. In such cases, too, all the operations connected with harvesting and the general care of the field call for much more tramping over the vines, with consequent injury. Perhaps even more important is the fact that, other things being equal, the black-head fireworm is far more prevalent and destructive on the large fields. The winter flowage favors this insect by driving from the field most of its natural enemies, such as spiders and parasites, while the water protects its eggs from unfavorable winter conditions. The natural enemies of the insect are, of course, later in again reaching the center of a large field than of a small one.

The field should be open to the sunshine and winds instead of being surrounded by high uplands and wood, for an open location is less subject to severe frosts, field conditions being the same, and the berries are more likely to set heavily, ripen early, and keep well when exposed to the maximum of sunshine.

Because of the many factors to be considered, only an experienced cranberry grower is competent to select a site for a cranberry field. One of the most successful growers says: "I have met with some failures, and these failures have shaken my faith in my ability to look at an untried swamp and state with certainty whether or not all the essential conditions for successful cranberry culture are there."

CLEARING THE SWAMP.

The actual clearing of a swamp should not begin until a survey has been made, streams and springs located, the position of ditches, dams, and reservoirs determined, and the cost carefully estimated.

The swamp may first be burned over to clear it of as much growth as possible; it may be flooded for two years to kill the brush and low growth; or without such preparations it may be cut over and grubbed and the brush burned.

Whether the swamp is to be cleared by burning, drowning out, or cutting over, the clearing can be done at least expense if preceded by draining. The main permanent ditch, at least, should be dug and with it such additional ditches as will facilitate operations. Figure 11 shows the drainage ditches being dug so as to make later work easier.

CLEARING BY BURNING.

Sometimes a fire running over the swamp in late fall or early spring will burn off much of the brush and save future expense. Care should be taken that the water table be held high enough to keep the peat from burning. If the water table is not kept near the surface, deep holes may be burned in the peat, so causing extra expense in leveling the surface as well as injuring the value of the peat.

CLEARING BY DROWNING.

When drowning is resorted to, all valuable timber is first removed, the main dams are built, and the entire area flooded for at least two years. Few plants of any kind survive this; all bushes and trees are

FIG. 11.—Digging drainage ditches in developing a cranberry field.

much more easily removed after flooding than before, and no weeds are left to cause trouble after cranberries are planted. This method can not be used in swamps where the peat will float. Drowning has been practiced commonly in New Jersey but not elsewhere. In that

FIG. 12.—Clearing a rough swamp in developing a cranberry field at Beaver Brook, Wis.

State it is considered the most practicable method of clearing a swamp of live vegetation. Because of the long wait involved and the loss of interest on capital invested, it is thought poorly suited to Massachusetts conditions.

CLEARING WITHOUT BURNING OR DROWNING.

After ditching and draining (see p. 19), all timber and brush should be cut and removed or burned, using the ax, brier scythe,

and billhook. If the brush is cut in late summer while still in leaf, the clearing usually can be done more easily than in winter, when water and frost are likely to interfere. Figures 12 and 13 show swamps being cleared.

FIG. 13.—Swamp land being cleared. In the foreground the trees and bushes have been cut and the turf cut and removed. Later the stumps must be dug out, the surface leveled and sanded, ditches dug, and dikes made. Wareham, Mass.

After all growth is removed, the land should be "turfed" or "scalped." The turf is cut with a cleaver or ax into strips about a foot wide and then with a turf hook turned bottom up in 12-inch squares. Sometimes the turf is carried to the upland or piled on

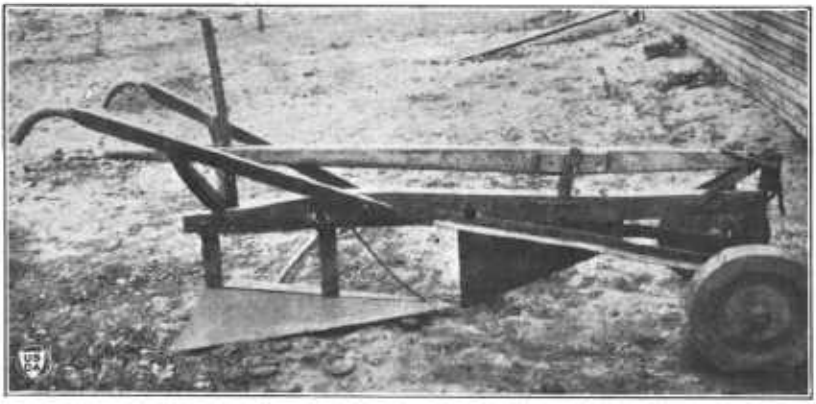

FIG. 14.—A scalping plow, used to cut turf loose in swamps which are free from bushes and trees. It is employed chiefly in Wisconsin, where conditions make it possible to use it to advantage. Under favorable conditions, using three horses, 3 acres a day can be scalped with this plow.

high spots in the swamp and burned. This, however, lowers the level of the field and should be avoided.

If horsebriers, equisetum, or ferns grow on the land, the turf, unless drowning is practiced, should be taken off and used for dikes

and roadways or disposed of otherwise. Stumps should be cut down below the level of the ground and covered with peat and sand. This saves the expense of removing them; their roots help in drainage, and they seem to possess lasting qualities for soil improvement. After a field has produced crops for several years the vines are commonly more thrifty and productive on spots where stumps are buried than elsewhere. Such fields must never be allowed to freeze deeply, as frost will cause heaving and make the surface rough.

In Wisconsin large areas of marshland formerly covered with wire-grass only have been planted to cranberries. A scalping plow

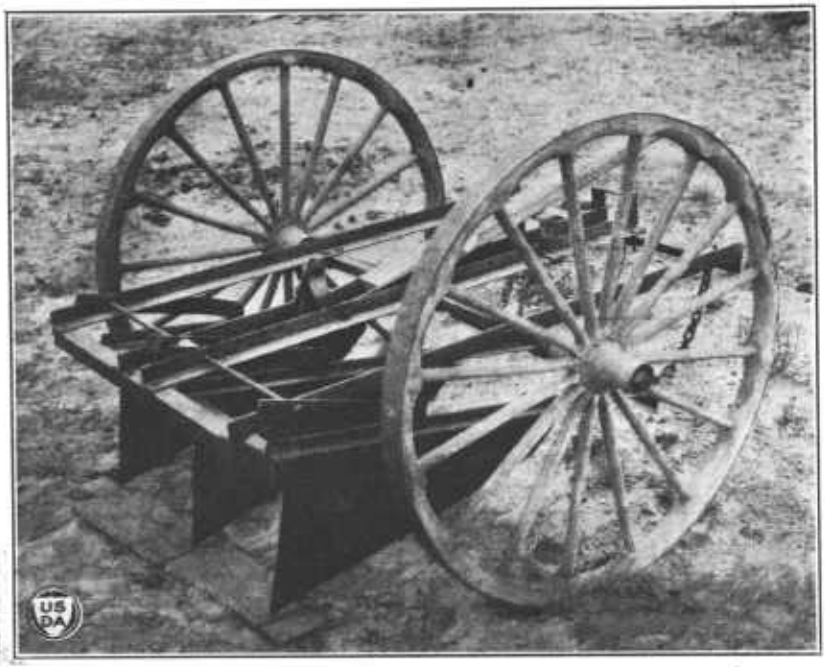

FIG. 15.—A 2-horse cross cutter used with a scalping plow to cut the turf into pieces of suitable size for handling. If the sod is tough, weights are placed on the frame. In the illustration the points of the knives are resting on a piece of board.

and cutter, shown in Figures 14 and 15, are used there in preparing areas already free from stumps and roots. The plow can be set to cut at the right depth below the surface. After it is used, the cutter (fig. 15) is run across the field at right angles to the direction taken in plowing, cutting the turf into pieces convenient to handle. Sometimes it is necessary to weight the cutter in order to make it sink deep enough. An implement used in Wisconsin instead of the scalping plow, where the roots of bushes abound, is illustrated in Figure 16. Figure 17 shows a field where the scalping plow and cutter have been used and the turf is being utilized to build dikes.

Special conditions, and they are numberless, will suggest many ways of reducing the cost of clearing.

DITCHING AND DRAINING.

The objects of ditching are (1) to drain the swamp thoroughly, (2) to maintain ample drainage after the property is developed, and (3) to furnish channels for the quick distribution of the water when the field is irrigated or flooded.

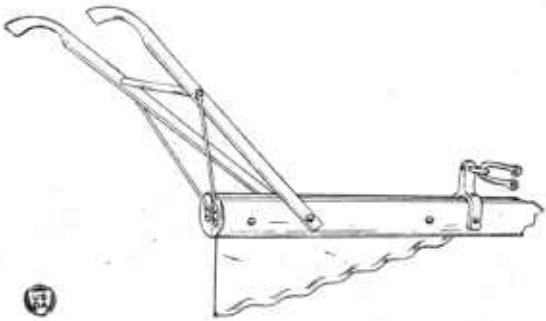

FIG. 16.—A single-shear peat cutter. Where roots make it impossible to use the scalping plow and straight-edge cutter, this device may be employed to advantage. The shear is made from quarter-inch sheet steel or a hard grade of sheet iron.

As each swamp has special features to be taken into account it is obviously impossible to give specific directions for ditching. Some swamps have springs that must be drained; some are composed of peat which allows the water to pass through quickly; others have compact soil, and the water drains off slowly. Special drainage plans are therefore required for each swamp, and a competent surveyor should make them.

Figure 12 shows the drainage ditches being dug. In general, there should be a wide main ditch in the path of the direct flow of water in the swamp large enough to carry off the surplus water in the rainiest seasons. As illustrating the importance of this precaution, during the season of 1919 unusually heavy rains fell in one

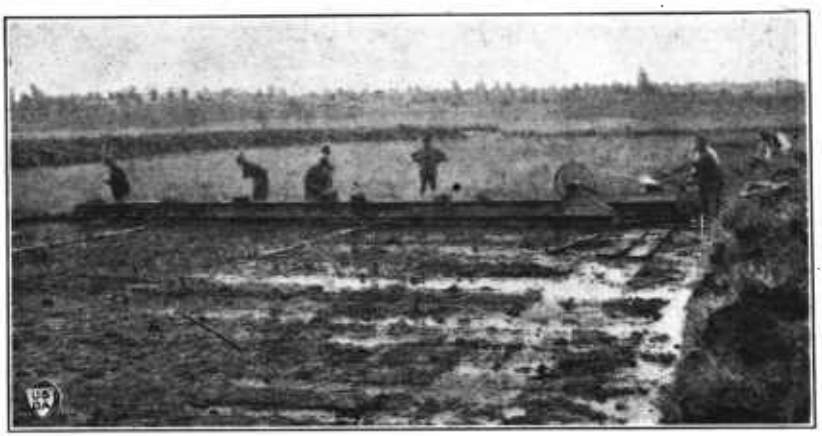

FIG. 17.—A field at Spooner, Wis., the turf of which has been scalped from the underlying soil and cut into pieces of convenient size. It is hauled to the dike at the right by a conveyor driven by a small motor. Under some conditions the turf can be removed cheaply with such equipment. Photographed in September, 1919.

cranberry section. The drainage ditches, adequate for normal conditions, could not carry off the water fast enough, and the crop on many properties was flooded for a week. The damage amounted to at least 50 per cent of the crop. Other sections have had similar experiences.

A ditch about 3 feet wide and 2 feet deep should be cut around the entire edge of the field. With an adequate outlet this will carry away any water coming from the upland as well as that from springs and underground watercourses. This will stop fires, many weeds, and some insects from spreading from the upland.

Cross ditches from the main ditch to the marginal must also be dug, the character of the swamp determining the distances between them. In Wisconsin these distances range from 4 to 15 rods, and in other cranberry regions they should rarely be less than 6 rods. No more ditches than necessary should be made, because of their cost and their interference with picking and other operations.

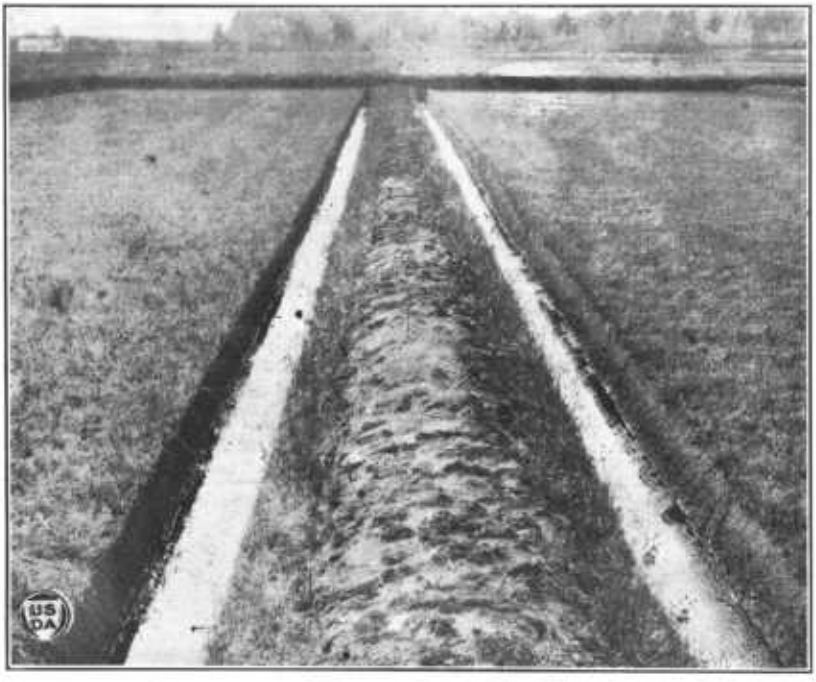

FIG. 18.—Ditches in a cranberry field. The material from these ditches was used to build the dike. Note the slope of the sides of the ditches. Photographed at Wisconsin Rapids, Wis., October, 1917.

The cross ditches generally should be 2 feet wide at the top, 10 inches wide at the bottom, and deep enough to lower the water table to at least 18 inches below the surface in the lowest places. The sides of the ditches should slope at an angle of about 60°. Figure 18 shows ditches with such sides. With this slope they do not need cleaning as often as they do with perpendicular sides.

RESERVOIRS AND WATER SUPPLY.

Water is used in cranberry flooding for the following purposes:

To prevent winter injury.
To protect the vines, blossoms, or fruit from frost.
To control insects.
To control weeds.
To irrigate during droughts.

Most growers have an ample supply of water for the winter flooding. Evaporation being less in late fall and winter than in summer, they have little trouble in keeping their vines properly covered during the winter, though small areas of so-called "dry bogs" are never flooded.

It is in the spring, summer, and autumn that water is often difficult to get in sufficient quantities. In northern Wisconsin, cranberry fields often have to be protected from frost every month of the growing season and sometimes in more than half the nights in September. Massachusetts and New Jersey growers are less troubled by frosts, but much water is nevertheless needed for proper protection from frosts and insects.

In the cranberry section of Wisconsin the average summer rainfall is about 4 inches a month. Over 11 inches fell in July of one year, and in the driest year less than one-half inch fell in August, with an average of less than 1 inch for the months of June, July, and August. On one occasion a drought lasted from July 21 to September

FIG. 19.—Water for flooding is let out of this reservoir through head gates or short flumes, one of which is shown at the left. The water is distributed by gravity. To conserve the supply a pump in the building is used to return the water from the fields to the reservoir. Photographed at Cranmoor, Wis.

6. Similarly variable conditions exist in Massachusetts and New Jersey. These instances suggest the imperative need of ample water supplies.

In the flat Wisconsin River valley the reservoirs are necessarily shallow and do not have large streams flowing into them. There the area of the reservoir generally should be at least equal to that of the area to be flooded and often three times its size. Unless the water is handled carefully, reservoirs no larger than the field to be flooded are insufficient during droughts or when frosts occur in quick succession. Figure 19 shows a corner of a Wisconsin reservoir where the water used for flooding is conserved by being pumped back into the reservoir.

In the East and in some parts of Wisconsin the land around the cranberry field is rolling or hilly and the reservoirs are commonly deeper or are fed by streams and so do not have to be as large as in a flat country. Often a stream furnishes a sufficient water supply for flooding and is, of course, the most economical and most satisfac-

tory source of supply. A special consideration in locating reservoirs in Wisconsin is the fact that many of the peat areas float when flooded. When this is the case the flow of water from the reservoir is retarded and may be reduced enough to be useless. As previously stated (p. 14), a reservoir, except perhaps in Wisconsin, should be located as far as practicable from the field.

PUMPS.

Many fields are now flooded by pumping from ponds, lakes, reservoirs, or streams. Pumping is satisfactory if the engine and pump are properly installed and kept in good running condition. The highest present lift of water by pumping in a cranberry property is about 14 feet, the usual lift being 3 to 6 feet.

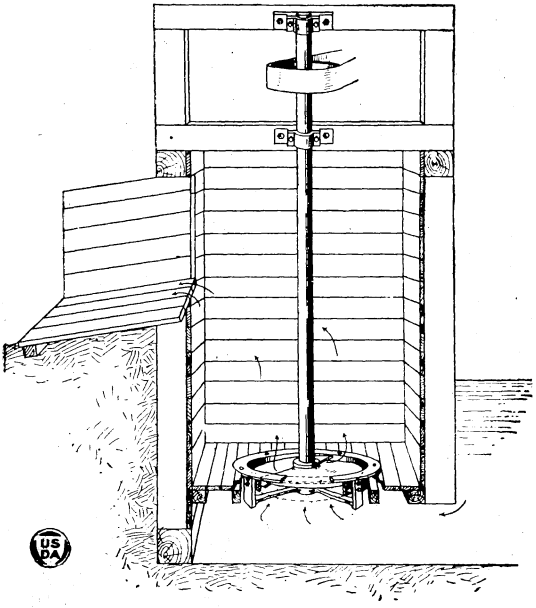

FIG. 20.—A propeller pump of large capacity, one of the most efficient types used in the Wisconsin cranberry districts.

A propeller pump is the most efficient type where the lift is 10 feet or less. Such pumps are about equal in efficiency to centrifugal pumps in 10 to 14 foot lifts. Centrifugal pumps should generally be used for all lifts greater than about 14 feet. Some forms of reversed turbines also have high efficiency as pumps at all ordinary lifts, but they are comparatively expensive and can not be used where sand or grit is present in the water.

There are various types of propeller pumps; some work in a snug-fitting casing and others merely in a hole in the floor of the pump box. The level of the pump must be that of the bottom of the reservoir or ditch from which the water is to be taken, while the bottom of the pump pit must be 15 to 30 inches lower. Some pumps are mounted in concrete boxes; others in boxes made of wood. (Figs. 20 and 21.)

Centrifugal pumps are of two types—the horizontal and the vertical or submerged type. They have about equal efficiency, but the vertical or submerged type is more desirable, as it requires no priming and little attention otherwise. The vertical type may be set in a head gate, flume, or box so arranged that when in use the water rises in it and overflows into the reservoir or ditch. No extra lift is made, and the height of the one lift increases only with the rise of the water in the reservoir or ditch. When pumping ceases, boards are dropped into place to check the return flow. Special

types of this pump used by many cranberry growers are more efficient than ordinary types. Figure 22 shows one type of the centrifugal pump in common use in Massachusetts.

A pump delivering 10,000 gallons a minute will flood 10 acres in 10 hours provided the soil is not very dry or the seepage great and the whole area to be flooded is not over 10 inches out of level. After the ditches have been filled to the level of the ground, a pump delivering 10,000 gallons a minute will apply an inch of water each half hour to 10 acres.

With a 5-foot lift a 40-horsepower engine gives ample power to pump 10,000 gallons per minute. Single cylindrical gasoline engines are used almost entirely to drive the pumps. Electric motors, because of their greater dependability, may in time supplant engines for this work in localities where electric power is not too costly.

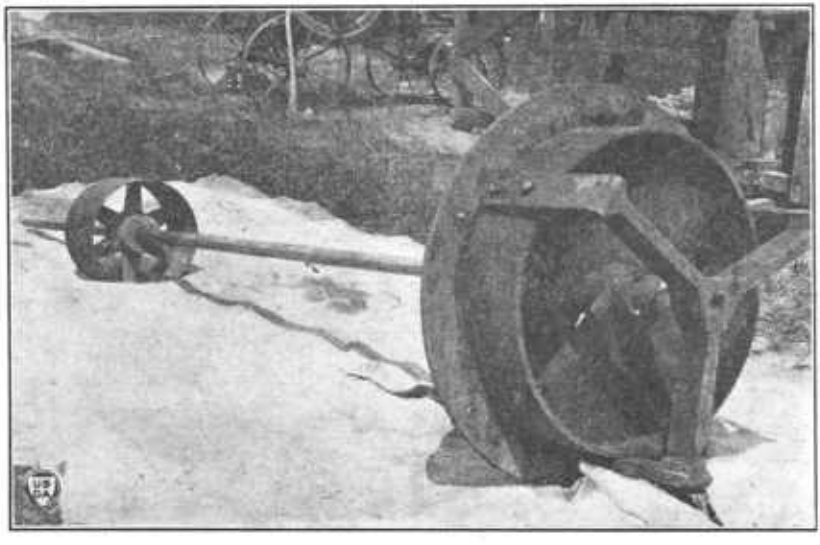

FIG. 21.—A propeller pump of the type shown in Fig. 20. This is one of the most efficient large-capacity pumps for low lifts and is commonly used by cranberry growers in Wisconsin. It may be used for lifts up to 12 feet, and for higher lifts by placing additional blades 8 feet up on the same shaft.

DAMS OR DIKES.

The dams built to hold water on cranberry fields or in their reservoirs are commonly called "dikes." Well-constructed dikes are necessary to hold the water in reservoirs and to maintain the summer and winter floods on the cranberry fields. Dikes are also built to separate a large field into sections in order to facilitate flooding and other operations.

The location of all dikes should be decided on and included in the survey made before clearing the swamp. Then, while the clearing, leveling, and ditching are being done, they can be built largely from surplus turf and ditch excavations.

The dimensions of the dikes vary according to the depth of water to be held. It is often best to build them wide enough to serve as roadways across the field.

If the swamp is large it should be divided into several flooding areas. Small areas can be flooded and drained more quickly than large ones, and the water usually can be maintained on them at a more uniform height. Also, when large fields are flooded, winds may cause the water to wash the dikes badly. On small sections this trouble is much reduced. Again, an insect that can be controlled by flooding may infest only one part of a field, in which case much water and labor can be saved, and sometimes a crop also, if the field has been wisely divided and only the affected part has to be flooded. If a field is much out of level, its division into several nearly level flooding sections of different elevations greatly reduces the quantity of water required in flooding. For example, if the location runs for a considerable distance along a stream, it is best to divide the swamp

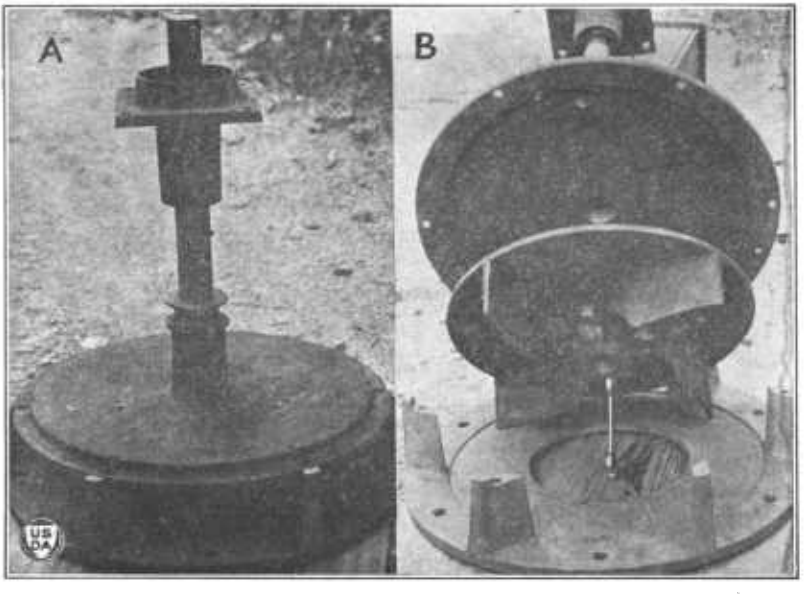

FIG. 22.—One of the simplest types of centrifugal pumps in common use by cranberry growers in Massachusetts: *A*, The pump as it appears in place; *B*, the same pump, showing its construction.

into several sections, each section nearly level in itself, but the various sections at different elevations according to the lay of the land and all separated from each other by dikes.

For convenience in applying water, a flooding section in Wisconsin should not contain more than 4 acres and in New Jersey not more than 15. In Massachusetts some sections contain over 100 acres, but those of 15 acres or less are relatively more profitable.

All dikes of turf and sand which hold large areas of water should be at least 2 feet higher than the high-water mark to keep the waves from washing over them. Dikes for small fields need not be more than 1 foot above high water.

Outlets should be large enough to carry off the overflow when heavy rains occur and to permit the quick discharge of water to be drained off after flooding to protect against frost.

In starting a dike, a trench should be dug along its central line to the bottom of the peat, or at least deep enough into the peat to form a good connection with it. The trench must reach below the level of all logs and roots; otherwise water will seep along them. The trench should be filled with sand, and this filling should be continuous with the core of the dike. The sides of the dike are walled with turf with a core of sand between them, as shown in Figure 23, and they should have a slope of about 60°. The top of the dike should be surfaced with sand. In building, an allowance of 1 additional foot in 5 of the height must be made for settling.

Dams are commonly allowed to grow bushes and grass. This is desirable, as the root growth serves to bind the soil together and make the construction firmer.

FIG. 23.—Building a dike for a cranberry field at Wareham, Mass. The central core is of sand, but the sides are of turf.

HEAD GATES.

Head gates, often called flumes and sometimes bulkheads, must be built in the dike for the passage of the water, and too great care can not be used in their construction. Experienced men should be employed in this work. Several kinds of head gates are in use. Reinforced-concrete head gates are considered the best for most purposes. Those made of lumber treated with a preservative and constructed with galvanized spikes are giving satisfaction in some sections; on soft land they are more practicable than those of concrete. The covered or trunk head gate is favored by some growers of experience. When built of untreated lumber a covered head gate will not rot out as quickly as an open one. The open head gate has been more generally built than the covered type and seems preferable, especially when built of treated wood or concrete and properly constructed. It should be connected with the soil beneath and the dike on its sides

by means of matched piling. If the head of water to be held is great and the soil underneath the dike is soft and sandy, it is best to use three or four lines of piling. A head gate should be built so that the water may be controlled from the top rather than from the bottom. Concrete head gates should have concrete wings reaching out several feet into the middle of the dike on each side to stop the passage of muskrats. The water is usually controlled by flashboards made to fit into slots on each side of the head gate and provided with large iron staples for convenience in handling with hooks. Figures 24 and 25 show large and small concrete head gates. Cranberry-field head gates should be built considerably wider in proportion to the water passing through them than they generally have been, for the wider the head gate the more quickly as a rule can flooding or draining operations be completed. In insect and frost flooding, the more promptly the water can be handled the better.

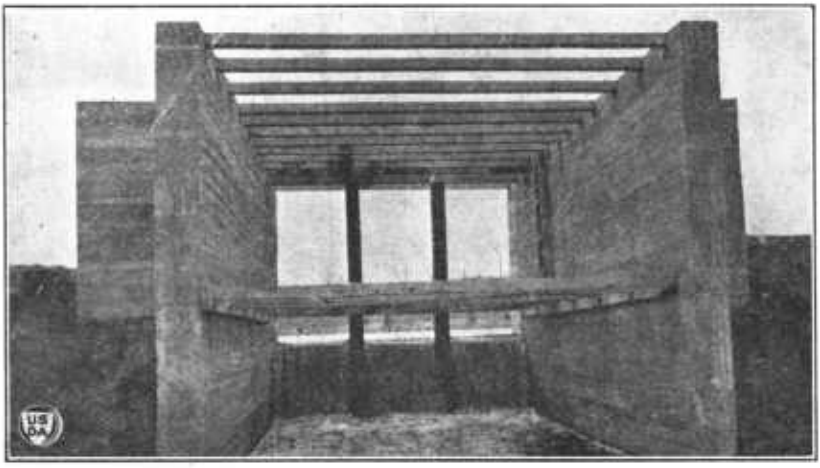

FIG. 24.—A concrete open head gate in a dike, for controlling the passage of water. The wings on either side, extending into the middle of the dike, help to hold the head gate in place and check leaks at the sides.

LEVELING.

It generally pays to grade a cranberry field to within a few inches of level, and most fields improved in recent years have been so made. The more nearly level the field, the less the quantity of water needed to flood it and the more quickly the water can be handled. Also, when the winter flowage is held late in the spring, as is sometimes necessary, a safe depth over the entire area can be maintained only when it is fairly level. In Massachusetts serious injury to the vines often results from the late holding of deep water. If the surface is uneven it may be best to divide the area into small fields having different levels. The levels may be ascertained from the water line in the ditches, or if dikes have been built the levels may be determined by flooding. A surveyor is sometimes employed to determine them.

Much of the grading can be done in connection with the clearing of the land. Depressions can be filled with turf from the high

spots and with material excavated from the ditches. The final leveling to fill small depressions should be done with sand.

In Wisconsin and on the Pacific coast, completion of the grading should await thorough draining, because of the possible floating of the peat. In one instance, a field planted before the ditches were finished was found later to be partly floating peat. Gullies 6 feet deep appeared in it, which had to be filled and the area replanted at great expense.

SANDING.

Sanding is practiced in all cranberry-growing regions except New Jersey and Wisconsin, and even in those States many growers sand all new properties they develop. When a layer of sand 3 inches or

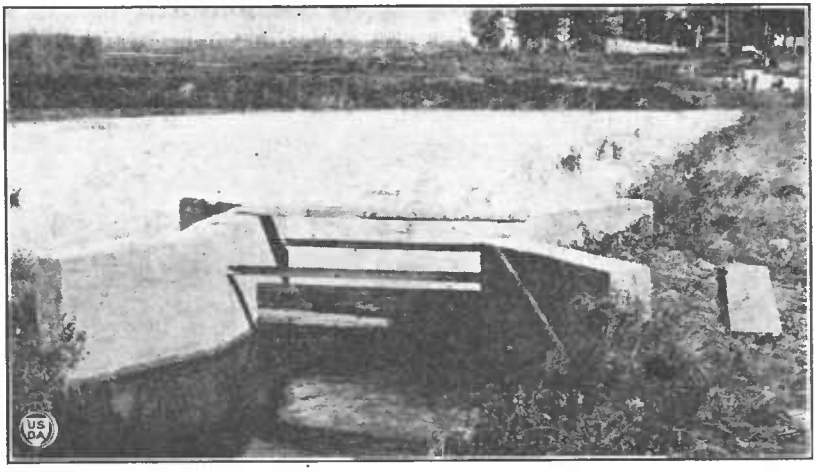

FIG. 25.—A small concrete head gate in a dike for controlling the passage of water. The field beyond is flooded to protect against a severe frost.

more thick is spread over the peat the following beneficial results are obtained:

The property is made more nearly level. Sand fills up the smaller depressions and other irregularities left in grading.

The cost of weeding is reduced, for weeds grow far less rapidly on clean sand than on peat. The lower cost of weeding is especially noticeable during the first two years after planting.

Vines grow much more vigorously on sanded areas, often covering the ground and smothering the weeds in two years. Such vines come into bearing earlier than those on unsanded peat.

Sanding helps to protect a field from frost. In Wisconsin, on cool nights in summer, sanding raises the temperature of the air above the vines higher than that above vines on unsanded peat. Wisconsin growers need such protection far more than those in the other sections, for their region is colder and more often visited by damaging frosts. However, all cranberry sections are subject to injury from frost and so need this protection.

Sanding helps to control certain injurious insects, such as the girder, tip worm, and green spanworm.

Sanded areas are capable of far better drainage and aeration than those of peat and are less likely to suffer in times of drought.

In New Jersey the berries seem to rot worse on sanded areas than on those not sanded. However, some growers have resanded regu-

larly, applying each time small quantities of sand, and their experience has shown that there is less danger from diseases than when large quantities are applied. Furthermore, because of insects and diseases affecting the cranberry, spraying is regularly practiced by many in New Jersey, and the fungi causing rots are largely held in check by that means.

The sand should be free from loam or other admixtures. In Massachusetts sand banks usually surround the area to be planted. If possible, the sand should be so taken as to facilitate the work in later years by making a roadway around the swamp or by making it possible to enlarge the field by setting vines on the land from which the sand is taken.

The surface sand of a sand bank should be discarded to a depth of 6 inches, as it generally contains weed seed and humus, both of which are undesirable on a cranberry field. Gravel pockets also

FIG. 26.—Sanding a cranberry field on the ice. Sand may be applied more uniformly and economically on the ice than directly on the dry field. Moreover, this method harms the vines less than any other.

should be avoided, as gravel unless screened is not suitable to use in place of sand.

In Wisconsin the sand is commonly spread in winter on the ice. The ditches are staked out before the ice forms, so that the sand may be applied only to the area to be planted. Advantage is taken of occasions when the water is frozen over and the snow not too deep for hauling the sand. Very much larger loads are hauled on sleds than could be carted in wagons. Figure 26 shows sand being hauled and spread on the ice. Sometimes in Wisconsin a planker is used to pack a heavy fall of snow before sanding, and so make the work easier.

Except in Wisconsin, sanding on ice is not a common practice, though there is no reason why it should not be done wherever the ice becomes thick enough to support a team. Sand spread evenly on the ice will fall evenly over the peat if the ice melts in position, as it will if the water is kept shallow.

When the sand is carried in wheelbarrows a plank track is laid from the pit across the field and moved as the surface is covered. Figures 27, 28, and 29 show fields being sanded in this way. When the field is very large or the sand bank is some distance away, the sand may be carried in large cars run on a rail track.

Massachusetts growers now generally prefer to put a layer of sand about 3 inches deep on a cranberry field at the time of construction and to apply another layer one-fourth to one-third of an inch deep after two seasons of growth, to induce the runners to root. Another similar resanding should be done the third or fourth season after planting, to induce a heavy stand of uprights. Vines so treated,

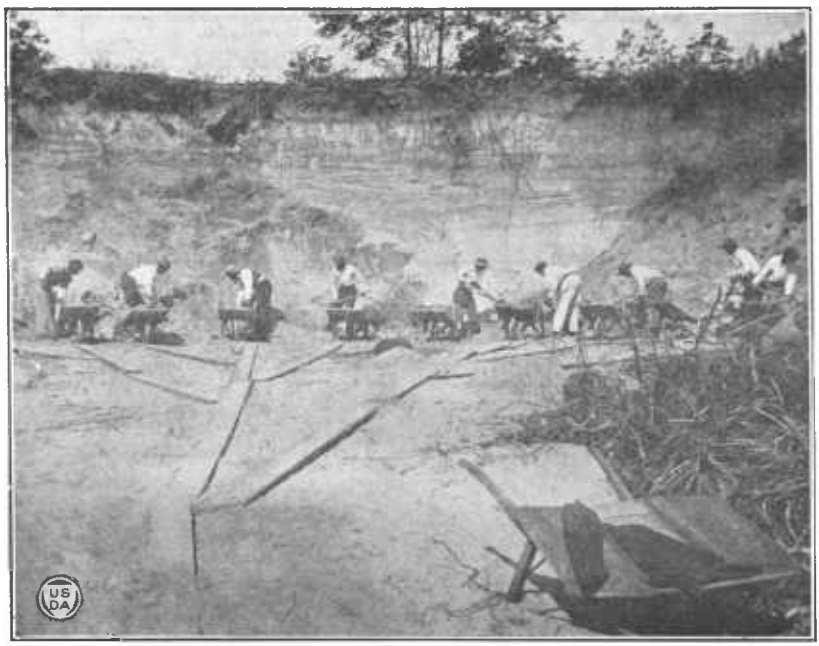

FIG. 27.—A sand pit adjoining a cranberry field in Massachusetts. Where possible, it is better to use the sand from a narrow strip along the edge of a field to make a roadway or to extend the cranberry field. Such a strip makes shorter hauls in resanding than where the sand pits are widely separated. Note the type of wheelbarrow used in this work.

being well anchored, are easily picked with a scoop and may be expected to yield large crops. A 3-inch layer of sand requires about 405 cubic yards to the acre.

VARIETIES.

Only one variety should be planted on the same flooding area. (See p. 24.) Some of the more important varieties have insect and fungous troubles which are more or less characteristic or peculiarly virulent with them, and the planting of several varieties susceptible to a number of different troubles on the same area often seriously complicates the problem of effective treatment by flooding.

The cranberry varieties now commonly grown are listed in Table 2.

TABLE 2.—*Varieties of cranberries and estimated percentages of the acreage of each grown in the different sections.*

State and variety.	Percentage grown (estimated).	State and variety.	Percentage grown (estimated).
New Jersey:		Wisconsin:	
Early Black	13	McFarlin	15
Howes	24	Searl	10
Centennial	3	Bennett	5
"Jerseys"[1]	50	"Natives," "Bell and Cherry"[2]	55
Other varieties	10	"Bell and Bugle," or "Berlins"	5
New York (Long Island):		Other varieties (Prolific, Metallic Bell, Howes, Early Ohio, Palmeter, Centennial, Matthews)	10
Early Black	52	Oregon and Washington:	
Howes	32	McFarlin	75
Other varieties	16	Other varieties (Searl, Bennett, Howes, etc.)	25
Massachusetts:			
Early Black	51		
Howes	40		
Other varieties	9		

[1] In New Jersey the crop from mixed unselected vines is sold under the designation "Jerseys."

[2] In Wisconsin the crop from mixed vines is sold under the designation "Natives." Because these vines have been selected to some extent and bear berries of bell and cherry shapes, they are sometimes known as "Bell and Cherry," and other mixed selections are designated "Bell and Bugle" or "Berlins."

FIG. 28.—Sanding a cranberry field after it has been leveled.

To show the relative value now placed on these varieties of cranberries, a list of those most planted in different States in the last 10 years is presented here, as follows:

New Jersey	Early Black, Howes.
New York (Long Island)	Early Black, Howes, Matthews, Centennial.
Massachusetts	Early Black, Howes.
Wisconsin	Searl, McFarlin, Bennett, Prolific.
Oregon and Washington	McFarlin.

Except for a few acres of Matthews and Centennial on Long Island, the Early Black and the Howes only have been planted in the East. They are fairly prolific, well known to the trade, and among the best keepers. Their vine growth is such that they usually can be picked readily with scoops. No variety superior to them for market purposes has as yet been found.

Both the Bennett and Searl varieties have been planted in central and northern Wisconsin, while in the south-central part the McFarlin is liked. Early Black and Howes do not do well in Wisconsin.

Many varieties have been tried in the Oregon-Washington region. The McFarlin is liked best, even though the fruit does not always mature evenly, and it can not be harvested widely with scoops. The Howes does not mature enough normal-sized berries in that region to be profitable.

The different varieties vary greatly in the time of ripening, the earliest usually becoming well colored by the end of the first week in September and the latest about the first of October. Some varieties color well in storage, while others will not redden much after they are picked.

The following characteristics of the leading varieties may assist in an understanding of their value:

Bennett (*Bennett's Jumbo*).—Originated at Fremont, Wis. Large size, oval in form, light red in color; late season; good keeper; will stand late picking. Subject to "false-blossom disease." Grown chiefly in central Wisconsin.

FIG. 29.—Spreading the sand evenly over the surface of a cranberry field.

Centennial.—Originated at Holliston, Mass. Largest variety grown in New Jersey; globose in form, light red in color; medium season; poor keeper. Vine grows too vigorously in New Jersey, except on savanna bottoms; productive, but planted little because of its poor keeping quality.

Early Black (*Late Red*).—Originated at Harwich, Mass. Medium size, pear shaped to oval in form, dark crimson; early; fair keeper. Vine fair for scooping; not as rank in growth as Howes. It is the principal early sort in the East, but is not early enough in Wisconsin to warrant planting. The berries increase in size during early September and keep well if picked before they become too ripe. They should be marketed before the holidays. This variety is more susceptible to the fruit worm than later ones. In New Jersey it is called "Late Red."

Howes (*Late Howe*).—Originated at East Dennis, Mass. Medium size, oval in form, dark crimson; late; long keeper. Vines excellent for scooping. Principal late variety in the East, but not productive in Wisconsin, and reported to mature unevenly in Oregon and Washington. In New Jersey it seems to succeed best on deep peat bottoms. In Massachusetts the later the berries are picked the better colored they become and the better they keep.

McFarlin.—Originated at South Carver, Mass. Large and irregular in size, oval in form, good color; midseason; good keeper in western regions, but an uncertain keeper in Massachusetts. Vines much given to runners and poor for scooping. The leading variety in central Wisconsin and among those liked best in the Oregon-Washington section.

Searl (Searl's Jumbo).—Originated near Wisconsin Rapids, Wis. Large size, oval in form, dark colored; midseason; fair keeper. Earlier and deeper colored than Bennett, but a poorer keeper. Grown in Wisconsin, and in recent years planted there somewhat more than other sorts.

PROPAGATION.

Cranberries are commonly propagated by pieces of vines, called cuttings, which root readily when pushed into moist soil.

SELECTION OF CUTTINGS.

The most important points to consider in securing cuttings are the purity of the variety, the condition of the vines, and their freedom from diseases and insects. The vines of most varieties on nearly all properties are more or less mixed, and only by propagating from those which are free from mixtures can a pure planting be obtained.

Cuttings should be taken only from fields with good records as to freedom from disease and insects. The nursery law of Wisconsin requires the inspection of vines offered for sale, and it is thought that this has helped materially to check the spread of the most common cranberry pests. Because of the gipsy moth, Massachusetts requires the inspection of vines for shipment to other States.

Cuttings should be secured as far as possible from new plantings or from areas recently renovated and making a vigorous growth. If an area bearing its first or second crop is used for cuttings, the vines will have an abundance of young wood which will grow better than cuttings from old vines. From a good field one barrel of cuttings per square rod or about 4 tons per acre can usually be secured.

HANDLING THE CUTTINGS.

The vines may be mowed with a scythe or mowing machine, packed in barrels or bags, and taken to the area to be planted. If packed with wet moss in ventilated barrels, they will keep in good condition for shipment across the continent or even to Europe.

If possible, the cuttings should be planted at once, but this is not always practicable. In any case they should be submerged in cold water as soon as received and taken out as needed. Cuttings soaked a few days bend more readily when pushed into the soil, as described later, than those not so treated.

The quantity of cuttings used in planting depends on their condition, the distance apart they are set, and the number used per hill. When set 16 by 16 inches, 4 or 5 barrels of Early Black are enough for an acre, while 6 barrels of Howes are required. Much larger quantities of cuttings from old vines than from young ones are necessary. For planting 6 by 8 inches, 1,600 pounds, or 20 barrels, per acre are needed.

PLANTING.

SEASON OF PLANTING.

Planting should be done from early April to the middle of May. Cuttings may be set throughout the summer, but if planted after the 1st of June they do not start well and make little growth. They

should be set as soon as possible after the sand is applied, as they do not start well if the sand is allowed to become packed with rains before planting.

FIG. 30.—Marking rows for planting cranberries. Wareham, Mass.

DISTANCE BETWEEN PLANTS.

The field should be marked out for planting with some such implement as is shown in Figure 30, to enable the cuttings to be set in straight lines and the planting made uniform.

In Massachusetts nearly all cuttings were formerly set 18 inches apart each way, but recently they have been planted 12 by 18 inches, 14 by 14 inches, and 16 by 16 inches. On the richer swamp lands 16 by 16 or 18 by 18 inches is satisfactory, but where the soil is mostly sand 9 by 18 or 6 by 18 inches is preferred. The closer together the vines are set the sooner they cover the ground, the less the necessity for weeding, and under some conditions the sooner a paying crop is secured.

FIG. 31.—Dibble for forcing cranberry cuttings into the ground. The blade is about 8 inches long.

In New Jersey the more common planting distances are 12 by 12 inches and 14 by 14 inches, while 8 by 8, 6 by 8, and 6 by 6 inches are recommended in Wisconsin. Growth is less rapid in Wisconsin because of the cooler season, and unless the cuttings are set closely a good stand is not obtained quickly, the securing of a profitable crop is delayed several years, and the cost of weeding becomes almost prohibitive.

The cuttings, 5 to 8 or 10 inches long, are pushed through the sand and about 1 inch into the peat underneath, leaving half an inch to 3 inches above ground. The dibble shown in Figure 31 is used in doing this. One man can plant about one-third of an acre a day when the cuttings are set 16 by 16 inches. Two or three cuttings are enough for each hill. Figure 32 shows a field being planted.

A few growers broadcast the vines over the field and either force them into the soil with a disk harrow or cover them lightly

with sand. This practice may save labor in planting, but is not advisable.

CARE OF A NEWLY SET PLANTATION.

For two or three weeks after cuttings are planted the soil should be kept moderately wet (but not flooded) by raising the water in the ditches. The water should be lowered as soon as the cuttings show signs of starting into growth.

In addition to raising the water in the ditches, attention must be given to the following: (1) Keeping the field free from weeds; (2) flooding during the winter and whenever it is necessary to protect the young growth from frosts or harmful insects; (3) resanding to induce runners to root; and (4) drainage.

FIG. 32.—Planting cranberry cuttings.

Winter flooding is practically the same for young cranberry fields as for bearing areas and is discussed in greater detail in Farmers' Bulletin No. 1401, "Managing Cranberry Fields." The water for winter flooding must be put on before the soil freezes much, or otherwise many plants will be thrown out, or "heaved," and killed. New plantings on sanded fields should be flooded about a month earlier than old fields. In Wisconsin new fields should be flooded about November 1; old fields are usually flooded about December 1. The water should not be raised after the vines have frozen into the ice, for the roots might be pulled out of the ground. In Massachusetts the water should usually be removed from young fields by April 25. After the first year it may be advisable to flood several times for a 2-day period during the growing season, to kill fireworms.

The drainage must be thorough in order to develop a deep root system. This will contribute to the vigorous growth of the vines and make the plants more resistant to drought.

WEEDING.

During the first year of growth, a hoe can be used in weeding. After that, however, if the vines have grown well, the weeds must be pulled or grubbed by hand.

Besides sanding, one of the most practical ways of reducing the cost of weeding in Wisconsin and in other sections, except on rich peat bottoms, is to plant a large quantity of cuttings per acre, to get the ground covered quickly. Fertilizers inducing a rapid growth of vines are sometimes helpful in the same way. Weeds should be smothered out or given no opportunity to grow.

To control weeds many growers hold the winter flood over the vines till the middle of June or even into July for a season or two before the first crop is expected. This late flooding drowns out some kinds of weeds and need not greatly injure the cranberry plants. Several

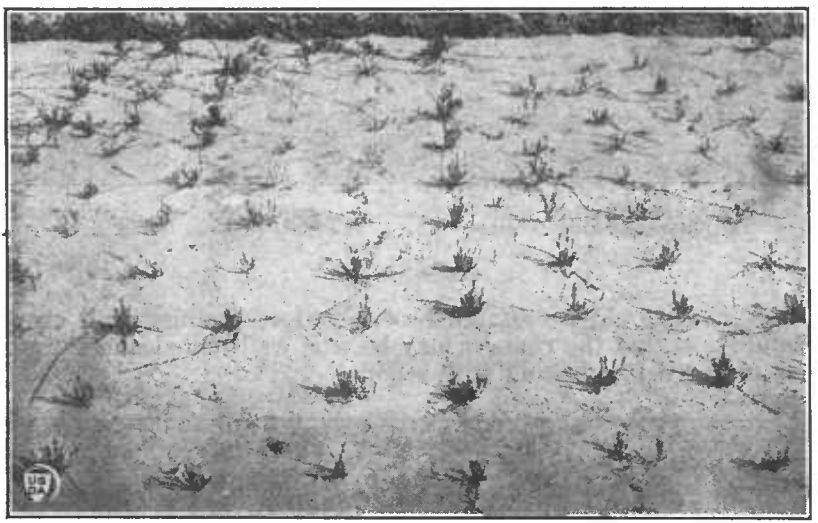

FIG. 33.—Cranberry cuttings set 18 by 18 inches apart in the spring, as they appeared the following September. Parker Mills, Mass.

kinds of weeds, including redroot, are not killed by this treatment, though many other serious ones are destroyed. If such late flooding is practiced in Massachusetts, the water should not be more than a foot deep over the vines, for deep late flooding in that section is usually very harmful to them. Moreover, this is a rather questionable practice for Massachusetts and New Jersey, because it subjects the fields to army-worm and cutworm incursions after the water is let off.

A vast amount of money has been wasted in Massachusetts in pulling and grubbing out weeds growing in cranberry fields. Mowing and drainage will keep down the species that usually occur there in greatest abundance, such as rushes, cotton grass, and sedges. In Massachusetts it probably is better to pull no weeds the first four or five years, except perhaps ferns and horse briers, depending on drainage and mowing for control during this time. Patches where the

weeds still prevail may be dug up and the area replanted as may become necessary at relatively little expense.

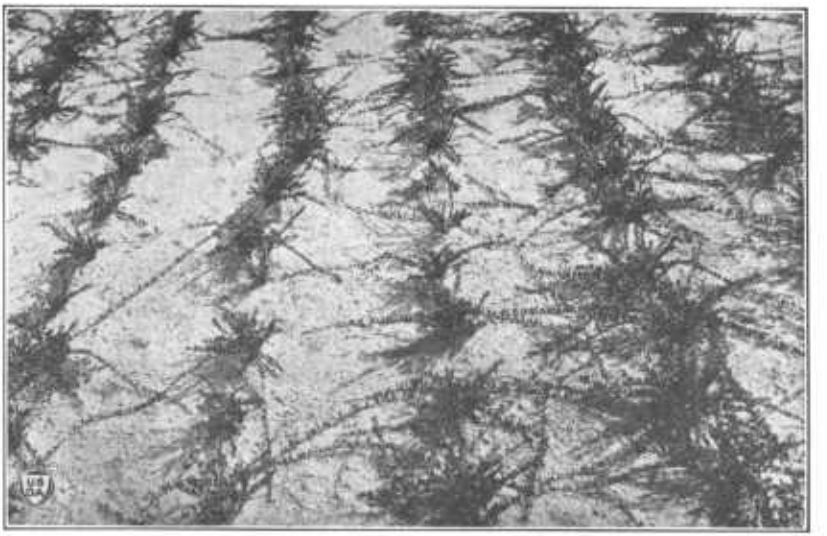

FIG. 34.—Cranberry plants set 6 by 18 inches apart in the spring. Photographed the following autumn (October 1, 1917) at Riverhead, Long Island, N. Y.

RESANDING.

The field should be resanded twice before the first full crop is produced, so that the runners may become well rooted and the vines well anchored for picking with scoops.

FIG. 35.—Cranberries set 18 by 18 inches apart. Photographed in September of the second season after planting. Parker Mills, Mass.

PRUNING.

Young cranberry vines should not be pruned until after they have borne one full crop. Pruning is then done for the purpose of

straightening out the vines, to make harvesting easier and to cut out extra runners.

A field usually comes into full bearing about four years after planting. In some cases the time is less; in others, more. Figures 33 to 35 show conditions in young fields after one, two, and three years of growth.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

November 10, 1923.

Secretary of Agriculture	HENRY C. WALLACE.
Assistant Secretary	HOWARD M. GORE.
Director of Scientific Work	E. D. BALL.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics	HENRY C. TAYLOR, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry	C. A. BROWNE, *Chief.*
Bureau of Soils	MILTON WHITNEY, *Chief.*
Bureau of Entomology	L. O. HOWARD, *Chief.*
Bureau of Biological Survey	E. W. NELSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Fixed Nitrogen Research Laboratory	F. G. COTTRELL, *Director.*
Publications	L. J. HAYNES, *in Charge.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board	J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration *Grain Future Trading Act Administration*	CHESTER MORRILL, *Assistant to the Secretary.*

This bulletin is a contribution from—

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Horticultural Investigations	L. C. CORBETT, *Horticulturist in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY.

▽